FIELD OBSERVATIONS ON THE ECOLOGY OF THE GOLDEN SUN MOTH, *SYNEMON PLANA* WALKER (LEPIDOPTERA: CASTNIIDAE)

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Abstract

Surveys for the distribution and relative abundance of the golden sun moth, *Synemon plana* Walker, were carried out in remnant grasslands of Macgregor West in western Belconnen, ACT. These surveys revealed that *S. plana* is concentrated mainly along the Ginninderra Creek corridor and its drainage lines, with the highest density of sun moths occurring in an open-grassland flood plain comprising improved pasture where the putative larval food plant, *Nassella neesiana* (Trin. & Rupr.) Barkworth (Chilean needle grass) (Poaceae), grows as the dominant species. The flood plain habitat and the sun moth's association with this perennial exotic grass from South America are both unique in terms of current ecological knowledge of this threatened castniid. Supplementary observations made at Reid in central Canberra, ACT, strongly suggest that *Bothriochloa macra* (Steud.) S.T. Blake (redleg grass) is also utilised. Further studies are needed to determine larval diet breadth and food plant preferences of *S. plana,* and to clarify the extent to which the species utilises introduced perennial grasses, in order to provide an effective conservation management plan.

Introduction

The golden sun moth, *Synemon plana* Walker, is currently listed as 'Critically Endangered' nationally, and 'Endangered' in all States and Territories where it occurs. It is limited to native temperate perennial grasslands and grassy open woodlands in southeastern Australia, and has been a flagship species for the conservation of these habitats.

Prior to European settlement, *S. plana* was widespread within this broad geographic area; historical records show it has been recorded from many localities from near Bathurst, New South Wales (NSW), through the Australian Capital Territory (ACT) and Victoria, to Bordertown, South Australia (Edwards 1993, 1994). However, as a direct result of habitat loss and degradation, its area of distribution has contracted substantially, with only a limited number of relatively small, isolated populations surviving within the now very fragmented landscape (Douglas 1993, 2004, Clarke and O'Dwyer 1997, O'Dwyer and Attiwill 1999, ACT Government 2005). Possibly less than 1% of the original breeding habitat now remains and weeds heavily degrade much of this. Clearing and habitat modification, particularly the conversion of native perennial grasslands for agriculture, either by ploughing or with the introduction of pasture grasses, are the primary factors responsible for the widespread loss of native habitat, particularly in NSW and Victoria. Urban and industrial development has also contributed to habitat loss and fragmentation (ACT Government 2005).

Prior to 2000, *S. plana* was known only from 12 sites in the ACT (Clarke and O'Dwyer 1997, Clarke and Dunford 1999) but, between 2002 and 2004, one of us (MD) located a number of additional sites in the ACT (sites being defined on the extent of their discontinuity with other habitat patches, and/or according to land tenure).

Currently, *S. plana* is recorded from 31 sites within the ACT and from 42 sites in NSW, all within 85 km of the northern and northeastern borders of the ACT (ACT Government 2005, Department of Environment and Conservation NSW 2005, M. Dunford unpublished data). These sites vary in size and quality: of the ACT sites, 14 (45%) are relatively small (< 10 ha, with a combined total area of about 50 ha), and some are possibly no longer extant, while 17 (55%) sites are considerably larger (> 10 ha, with a combined total area of about 740 ha). However, ACT Government (2005) estimates that only about 20% of grassland patches where the species is known to occur in the ACT are protected in reserves, although this is likely to increase to around 25%. Eight of the ACT sites are significant in terms of the extent of the breeding area and/or relative abundance, and have high conservation value (ACT Government 2005). All sites in the ACT and nearby areas in NSW occur below 700 m.

The life history and larval food plants of *S. plana*, and indeed for the genus *Synemon* Doubleday, are poorly recorded in the literature, with only *S. magnifica* Strand described in detail (Common and Edwards 1981, Edwards *et al.* 1999). The food plants of *Synemon* comprise various monocotyledons, including Poaceae, Cyperaceae, Ecdeiocoleaceae and Lomandraceae (Edwards 1996, Edwards *et al.* 1999).

The putative larval food plants of *S. plana* include species of native perennial grasses in the genera *Austrodanthonia* H.P. Linder (wallaby grass) and *Austrostipa* S.W.L. Jacobs & J. Everett (speargrass) (both Poaceae). In the ACT, the preferred species is apparently *Austrodanthonia carphoides* (Benth.) H.P. Linder (Edwards 1990, 1993), although at some sites where this grass is absent or in very low abundance other species are almost certainly utilised (A. Rowell pers. comm.). In Victoria, *S. plana* is associated with several species of *Austrodanthonia* (Douglas 1993, O'Dwyer and Attiwill 1999), as well as *Austrostipa scabra* (Lindl.) S.W.L. Jacobs & J. Everett in the Wimmera (F. Douglas unpublished data). The larvae of *S. plana*, like many other Australian castniids, feed underground on the roots.

Here, we report on general observations made on the habitat preference and putative larval food plant of *S. plana* at a hitherto unknown site in Macgregor West, ACT, which one of us (MFB) first located in December 2002. The site occurs 3 km south-west of an extant colony in the Dunlop Grasslands Nature Reserve of western Belconnen. Additional observations made at a site in Reid in central Canberra, first recorded in November 2003 by MD, are also included.

Field observations

Macgregor West

Field surveys for the presence and relative abundance of *Synemon plana* were conducted in remnant grasslands of the Macgregor West district (35°12'S, 149°00'E; 560 m a.s.l.) in western Belconnen, ACT, during 7, 17 December 2003 and 5, 11-22 December 2004 (Braby 2005). These surveys revealed that *S. plana* was abundant and widespread in the area (total breeding area *ca* 70 ha) and more extensive than the colony nearby at Dunlop Grasslands Nature Reserve, the only other known extant site in western Belconnen. However, the population was found to be concentrated mainly along Ginninderra Creek and its drainage lines, with the core breeding area occurring in an open grassland flood plain comprising improved pasture (Fig. 1). This flood plain habitat stretched as a broad linear strip, approximately 700 m long by 100-200 m wide, along the Ginninderra Creek corridor north-west to the confluence of Gooromon Creek, and then continued more narrowly (*ca* 30-40 m wide) for about 1 km south-west along Ginninderra Creek towards the ACT/NSW border.

Within the flood plain habitat, patrolling males of *S. plana* were noted to be strongly associated with extensive patches of introduced Chilean needle grass, *Nassella neesiana* (Trin. & Rupr.) Barkworth (Poaceae), formerly known as *Stipa neesiana* Trinius & Ruprecht (Jacobs and Everett 1996). This grass species is the dominant plant in the flood plain habitat at Ginninderra Creek (Rowell 2005). Subsequently, 12 empty pupal shells (5 of which were collected, 1 lodged in ANIC) were discovered protruding out of the soil amongst tussocks of *N. neesiana* in various locations along the flood plain (Fig. 2). In each case, no other species of grass, native or introduced, was found near the pupal shells, indicating that *N. neesiana* is probably used as a larval food plant in the Ginninderra Creek flood plain.

A second, smaller, concentration of sun moths was found to occur in open grassland comprising degraded native pasture on higher sloping ground in Macgregor West, about 300 m west of Ginninderra Creek. The larval food plant was not determined in this habitat; however, the slopes are dominated by *Austrostipa bigeniculata* (Hughes) S.W.L. Jacobs & J. Everett, with *Austrodanthonia* comprising only a small component (Rowell 2005).

Reid

At St John's Anglican Church, Reid (35°17'S, 149°08'E; 570 m a.s.l.) in central Canberra, ACT, a female *S. plana* was observed emerging from its pupal shell at 1115 h (EDST) on 14 November 2003. The specimen was captured and held for about 25 minutes while it expanded and dried its wings, and then released. The pupal case was noted protruding from a plant of *Bothriochloa macra* (Steud.) S.T. Blake (redleg grass), a native species endemic to southeastern Australia. Nine empty pupal shells (1 lodged in ANIC) were subsequently discovered protruding from within, or directly

adjacent to, tussocks of *B. macra* on 22 November 2003. In each case, the nearest other grass species was 30 cm or more from the pupal shell. A further four pupal shells were found closely associated with *B. macra* on 8 December 2005, when several females were also observed ovipositing at the base of this species between 1300-1400 h (EDST). The St John's Anglican Church site comprised a small (*ca* 0.2 ha), fragmented and highly disturbed urban remnant patch of grassland dominated by *B. macra, Trifolium* spp. and *Paspalum dilatatum* Poir.

Figs 1-2. *Synemon plana* ecology at Ginninderra Creek, Macgregor West, ACT: (1) open grassland flood plain habitat, with patches of *Nassella neesiana* in foreground; note cattle grazing in background. (2) pupal exuvium protruding from tussock of *N. neesiana*. Photos: M.F. Braby.

Discussion

The presence of *Synemon plana* in an open grassland flood plain ecosystem and its association with *Nassella neesiana*, an exotic grass introduced from South America, closely related to *Stipa* L. and more distantly related to *Austrostipa* (Gardner *et al.* 1996, Jacobs and Everett 1996), represent a unique situation that contrasts markedly with all other known sites of *S. plana* throughout its range (Edwards 1994, Douglas 2004, ACT Government 2005). The density of sun moths in this flood plain habitat is also extremely large; for example, during the peak flight period in mid December 2004, close to 1200 individuals were counted along a 650 m x 50 m transect in the Ginninderra Creek flood plain (Braby 2005). Much of the habitat in the flood plain has been grazed by cattle (Fig. 1), which have significantly reduced both the plant biomass and competition from other weeds, creating conditions beneficial to *S. plana*, although in early 2005 cattle were excluded from the area (Rowell 2005).

Further long-term studies are needed to determine if the occurrence of *S. plana* in the flood plain represents the normal situation or is an unusual (short-term) response to extreme dry conditions that have occurred over the past three seasons (2002-2005). *S. plana* also occurs in significant numbers in the central drier slopes of Macgregor West, a short distance from Ginninderra Creek; it is possible that this secondary area serves as an important breeding habitat during wetter years when the flood plain may be potentially unsuitable for larval survival.

Although the presence of pupal shells provides only circumstantial evidence, it is highly likely that *S. plana* is utilising, as larval food plants, *N. neesiana* at the Ginninderra Creek flood plain in Macgregor West and *Bothriochloa macra* at the St John's Anglican Church site in Reid, particularly since the larvae are believed not to move underground between roots of adjacent grass tussocks (F. Douglas pers. comm., A. Rowell pers. comm.). Moreover, in the former habitat, *Austrodanthonia* comprises a relatively minor component (< 5% cover), whereas *N. neesiana* is the dominant species, growing in relatively large patches with up to 70% cover abundance in surveyed quadrats (Rowell 2005). Similarly, at the latter site, *Austrodanthonia* comprises less than 10% cover (M. Dunford unpublished data).

In the Ginninderra Creek flood plain, *N. neesiana* has possibly displaced much of the native grasses normally utilised by *S. plana*. Presumably, *S. plana* has been able to supplement or even switch its larval diet to a related but non-indigenous plant. Such a switch, however, does not necessarily imply that *S. plana* is dependant on *N. neesiana*; nor has it adapted to a range of other introduced grasses, many of which are weeds in the Australian landscape. On current knowledge, *S. plana* should be regarded as an ecological specialist dependent on a narrow range of native grasses (*Austrodanthonia, Austrostipa*, *Bothriochloa*) and, in some circumstances,

also utilises an introduced grass (*Nassella*) when the native grasses have been significantly depleted. Clearly, further studies are needed on the ecological requirements of *S. plana* and to clarify the extent to which the sun moth utilises *N. neesiana*.

The association of *S. plana* with *N. neesiana* is of biogeographical interest because the castniids have a Gondwanan distribution pattern, with disjunct occurrences in Australia, Central and South America, and Asia (Edwards *et al.* 1999). Members from Australia and Central and South America belong in the subfamily Castniinae, while those from Asia are currently placed in the subfamily Tascininae.

The Castniinae are composed of two tribes: the Synemonini, which are restricted to Australia, and the Castniini, which are endemic to Central and South America. [The Castniinae have recently become established in the Mediterranean through accidental introduction: Sarto I Monteys *et al.* 2005]. Both of these tribes are believed to be monophyletic and represent vicariant sister groups that differentiated after the break-up of southern Gondwana (Australia-Antarctica-South America) (Holloway and Hall 1998). It is therefore possible that the association of *Synemon* (endemic to the Australian Region) with *Nassella* (endemic to the Neotropical Region) may reflect an historical biogeographic relationship between the castniids of Australia and South America.

In South America, *N. neesiana* occurs widely in the cool montane areas of the Andes in Ecuador, Peru, Bolivia and Argentina, as well as in the temperate areas of southern Brazil, Paraguay and Uruguay (Missouri Botanic Garden 2005). In Chile, however, it is rare and restricted, currently protected and listed as a threatened species (A. Ugarte pers. comm.). *Nassella* is not known to serve as a larval food plant for the Neotropical castniids, but food plants (all monocots, including the families Arecaceae, Bromeliaceae, Marantaceae, Musaceae, Orchidaceae, Poaceae) have been recorded for only a few species of Castniini (Edwards *et al.* 1999, Sarto I Monteys *et al.* 2005), most of which occur in tropical forest. Only one species, *Castnia eudesmia* Gray, which feeds internally on the flower stems of *Puya chilensis* Molina (Bromeliaceae), is known to occur in the temperate areas of Chile (A. Ugarte pers. comm.).

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